BABEȘ - BOLYAI UNIVERSITY
Faculty of Chemistry and Chemical Engineering

Carbon Capture and Storage Workshop

ACT funded projects from Babeș - Bolyai University

Prof. PhD Eng. Calin-Cristian Cormos

20 June 2018

Bucharest, Romania

Matchmaking for ERA-NET Cofund ACT projects (2016 call)

Accelerating CCS Technologies

Template for insitutional information to ACT

We hereby provide information from our institution/department/industry to be included in the list of CCS-institution/industry to be published on the ACT-homepage (www.act-ccs.eu).

1. **Name of Institution:**
   Universitatea Babes-Bolyai Cluj-Napoca
2. **Abbreviation:**
   UBB
3. **Department:**
   Chemical Engineering
4. **Speciality (ies) field within CCS:**
   Carbon capture, utilisation and storage technologies, Gas-liquid absorption, Chemical and calcium looping, Modelling, simulation and process (thermal) integration, Energy conversion systems with CCS, Energy-intensive industrial applications (e.g. cement, metallurgy, chemicals etc.) with CCS, Energy vector poly-generation, Techno-economic and environmental (Life Cycle Assessment - LCA) evaluations
5. **Web-page:** http://www.chem.ubbcluj.ro/en/
6. **Other info:**
7. **Contact person:**

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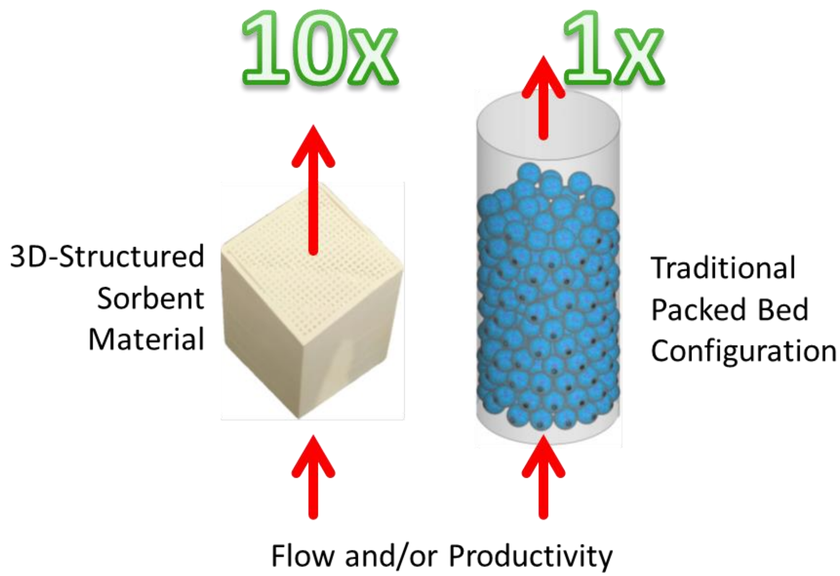
Applications:

- **3D-CAPS (small project)**
- **GaSTech (small project)**
- **CapeWaste (big project)**

Granted projects:

- **3D-CAPS (small project)**
- **GaSTech (small project)**

Three Dimensional Printed Capture Materials for Productivity Step-Change (3D-CAPS)



Main objective is to use the latest 3D printing techniques to realize an order of magnitude size reduction for solid sorbent technologies targeting two applications:

- **Medium temperature (300-500°C), Pressure Swing Adsorption using alkali-promoted hydrotalcites, Sorption-Enhanced Water-Gas Shift for syngas processing with CO_2 capture**
- **Low temperature (40-130°C), Pressure Swing Adsorption using amine-functionalized silicas to replace traditional solvent-based systems for CO_2 and other acid gases removal**

3D-CAPS Project Consortium

UNIVERSITATEA BABEȘ-BOLYAI

AkerSolutions

CCP

ECN › TNO innovation for life

SINTEF

3D-CAT B.V.

3D-CAPS Project – UBB role

Optimization of structure configuration and processes through modelling

Project WPs

WP No	WP title	Lead	Participants
WP1	Paste formulation and 3D-printing	ECN	SINTEF; 3DCAT
WP2	Pre-Pilot testing up to TRL5	SINTEF	ECN; 3DCAT
WP3	Optimization of structure configuration and processes through modelling	UBB	ECN; SINTEF; 3DCAT; CPP; AKSO
WP4	Business development and Exploitation Plan	3DCAT	ECN; SINTEF; CPP; AKSO
WP5	Project lead and dissemination	ECN	SINTEF; UBB; CPP; 3DCAT; AKSO

UBB Tasks:

- **Definition of structures to be modelled and manufactured**
- **CFD modelling of structures**

Deliverables:

- **Definition of structures to be modelled**
- **CFD structure modelling (for sorption-enhanced water-gas shift systems)**

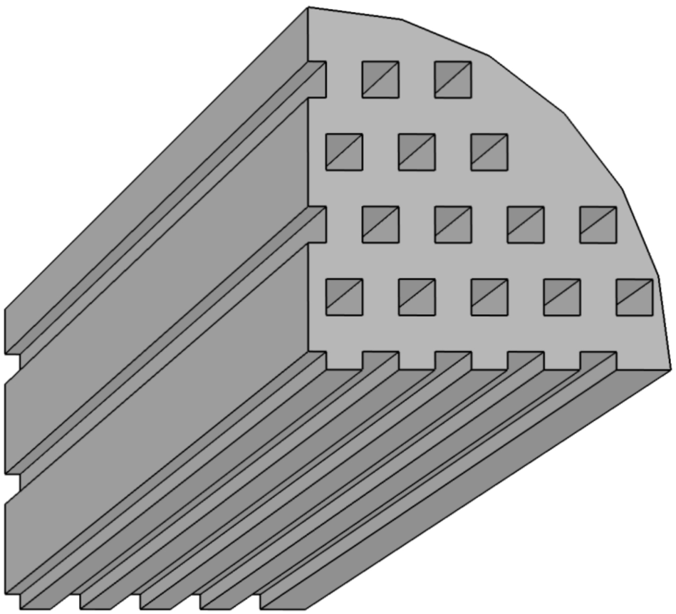
Milestone:

- **Super-computing cluster interaction and license for CFD modelling**

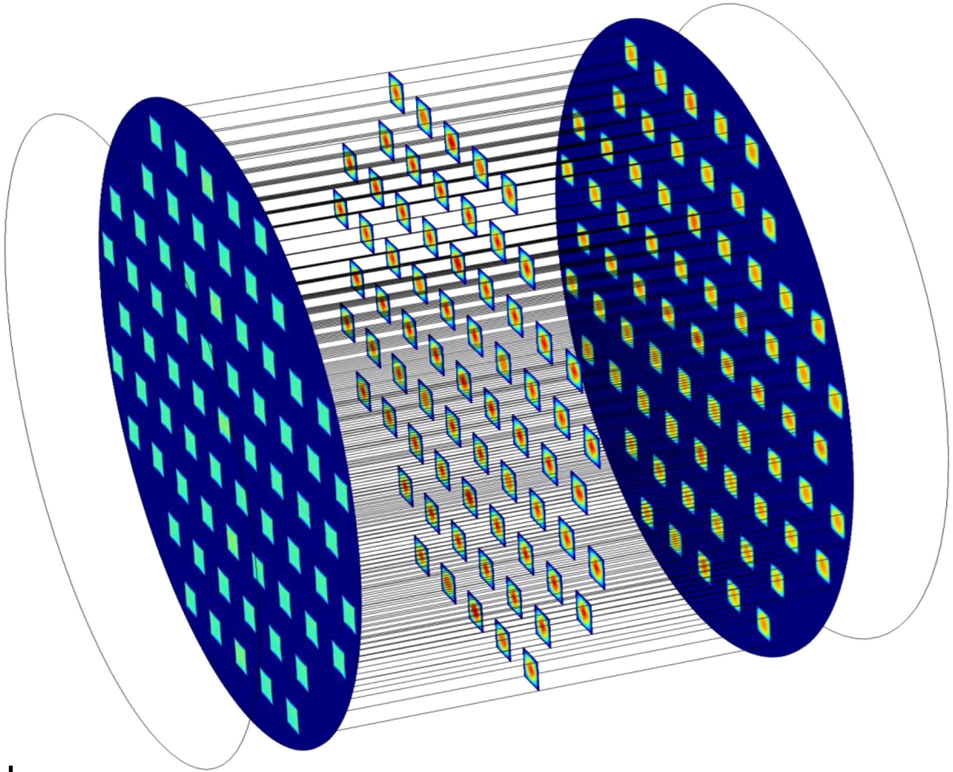
3D-CAPS Project – UBB role

Optimization of structure configuration and processes through modelling

Simple/simplified 3D model - simulation of flow through rectangular channels

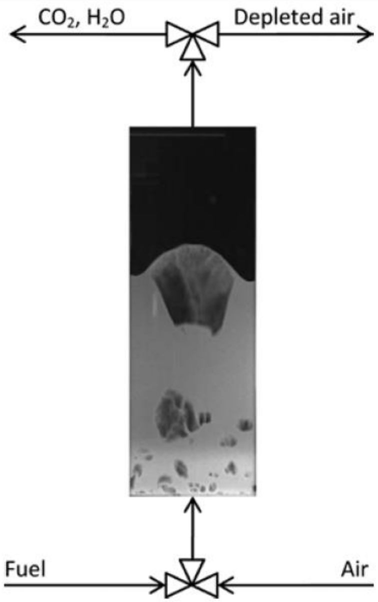


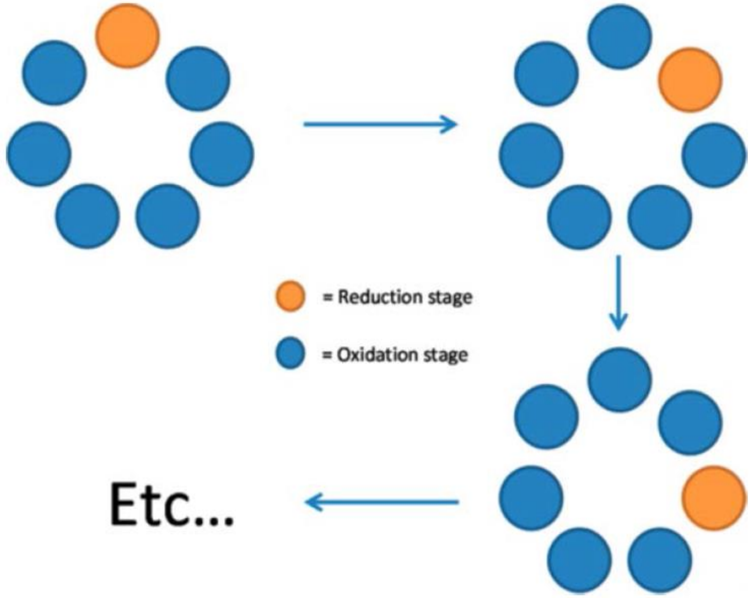
Quarter of full geometry of monolith (with 69 rectangular square channels with sides of 2 mm and length of 1 m)



COMSOL simulation results

Demonstration of Gas Switching Technology for Accelerated Scale-up of Pressurized Chemical Looping Applications (GaSTech)





Main objectives:

- Demonstrate autothermal pressurized operation of gas switching combustion (GSC), reforming (GSR), water splitting (GSWS) and oxygen production (GSOP) in fluidised bed lab-scale reactors
- Techno-economic assessments for promising CO_2 capture process configurations utilizing above mentioned gas switching technologies

GaSTech Project Consortium

SINTEF

NTNU

UNIVERSITATEA BABEȘ-BOLYAI

UNIVERSIDAD POLITECNICA MADRID

HAYAT

euro support

ETH zürich

GaSTech Project – UBB role

Economic assessments of gas switching technologies

Project WPs

WP No	WP title	Lead	Participants
WP1	Materials selection, testing and manufacturing	ETH	ESAM
WP2	Demonstration of pressurized GSC, GSR, GSWS and GSOP operation	SINTEF	NTNU
WP3	Large-scale process simulation of gas switching technology	TUHH	UPM SINTEF NTNU
WP4	Economic assessments of gas switching technology	UBB	ESAM
WP5	Business case	HAYAT	
WP6	Management and dissemination	SINTEF	

UBB Tasks:

- **Definition of main economic assumptions and benchmark cases**
- **Economic assessments of gas switching technologies**

Deliverable:

- **Economic assessments of (at least) two gas switching process concepts**

Milestone:

- **Identification of the best performing technologies for the business case**

Main economic performances:

- **Total investment cost:** $TIC = \sum Equipments\ costs\ (purchase + installation) + Contingencies$

- **Specific capital investment (SCI) per kW net power / hydrogen output (LHV):**

$$SCI\ per\ kW(net) = \frac{Total\ investment\ cost}{Net\ power\ output\ /\ Hydrogen\ thermal\ output\ (LHV)}$$

- **Specific operating costs (SOC) per kWh net power / hydrogen output (LHV):**

$$SOC\ per\ kW(net) = \frac{Total\ operating\ cost}{Net\ power\ output\ /\ Hydrogen\ thermal\ output\ (LHV)}$$

- **Levelised cost of electricity (LCOE) and levelised cost of hydrogen (LCOH)**

- **CO_2 capture costs:**

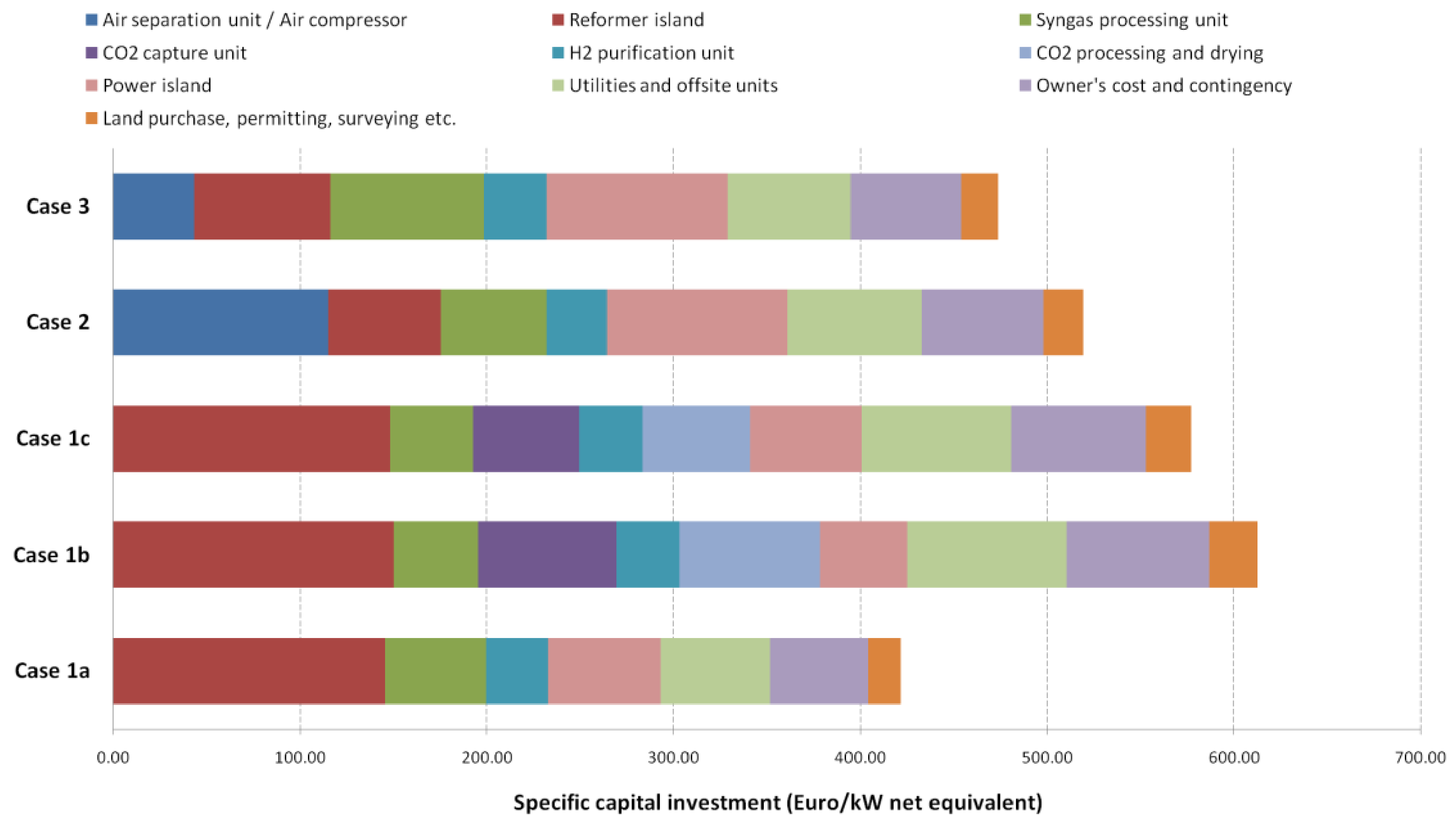
$$CO_2\ removal\ cost = \frac{LCOE_{with\ CCS} - LCOE_{without\ CCS}}{CO_2\ removed}$$

$$CO_2\ avoided\ cost = \frac{LCOE_{with\ CCS} - LCOE_{without CCS}}{CO_2\ emissions_{without CCS} - CO_2\ emissions_{with\ CCS}}$$

GaSTech Project

Economic assessments of gas switching technologies

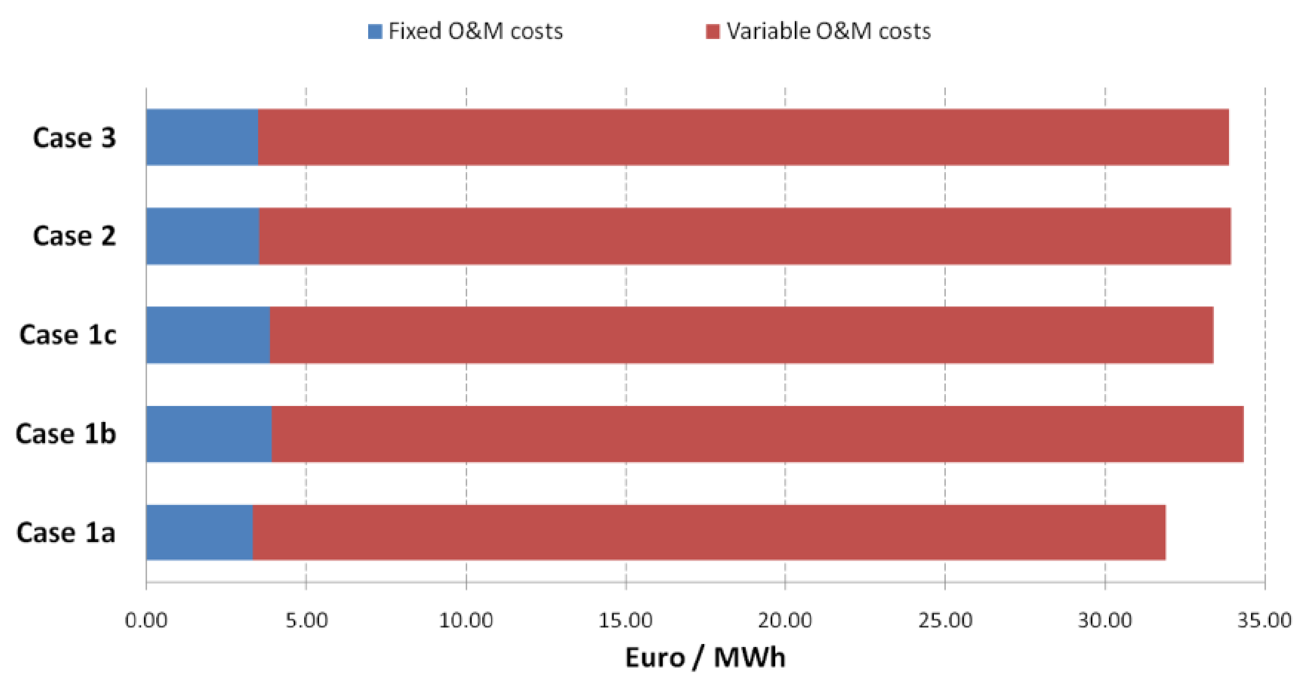
SCI costs for natural gas reforming-based H_2 production concepts (benchmark cases)



GaSTech Project

Economic assessments of gas switching technologies

SOC costs for natural gas reforming-based H_2 production concepts



Costs of hydrogen & electricity and CO_2 capture costs

Main plant data	Units	Case 1a	Case 2	Case 3	Case 1b	Case 1c
Levelised cost of hydrogen (LCOH)	€ / MWh	37.72	41.10	39.63	43.03	41.64
Levelised cost of electricity (LCOE)	€ / MWh	38.15	40.90	38.55	43.20	41.77
CO_2 removal cost	€ / t	-	-	-	27.40	30.59
CO_2 avoided cost	€ / t	-	-	-	29.85	21.86

Thank you for your attention!

Contacts

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